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ABSTRACT

Educators are constantly seeking new ways to capture the attention of students and create active learning environments where minds are engaged and students are nurtured. The full potential of the Internet as a tool for learning is still being explored. This digest offers some examples of ways in which the Internet can be used as a tool for teaching and learning science. Sections include: (1) "Facilitating Productive Interactions"; (2) "Finding New Sources of Information"; (3) "Seeking Assistance"; (4) "Staying Informed"; (5) "Extending Classroom Activities"; (6) "Doing Research"; (7) "Getting Involved in Projects"; and (8) "Enrich Personal Experience." (CCM)

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We are continually seeking new ways to capture the attention of students and create active learning environments where minds are engaged and interests are nurtured. The Internet is a powerful tool for engaging minds: school groups and individual students can collaborate on projects; students can pursue individual interests, taking responsibility for gathering their own information; and everyone can communicate with peers and experts worldwide. For teachers, the Internet is an electronic gateway to learning resources and experiences otherwise unavailable; no matter how specialized an area of interest may be, there is someone on the Internet who shares the interest and has identified or developed useful resources. It is through interaction with other people, ideas, and new experiences that we all construct new knowledge, and the power of the Internet is in its capacity to enable interactions with people over great distances and link people with distant informational resources. In essence, the Internet provides a way to break out of the school walls and engage students with people and resources scattered around the world.

The full potential of the Internet as a tool for learning is still being explored, but one of the main limitations at the moment may be our imaginations. We are still gaining the experiences that will enable us to envision the possibilities. Here we offer some examples of ways in which the Internet can be used as a tool for teaching and learning science.

Facilitating Productive Interactions

Because individuals can interact inexpensively without needing to coordinate the times or places of their interaction, virtual conversations are possible between individuals with very different schedules. Using electronic mail, a teacher can interact individually with students or their parents, send informational messages over a Listserv to a whole group, or provide assistance and access to electronic resources through a personal website. With these Internet communication tools, a teacher can actually provide increased individual attention while spending less time in meetings, extended conversations, or talking on the telephone.

The Internet also makes it possible for a class or group to interact with other school groups at great distances. For instance, one school coordinated an experiment with 11 other class groups from as far away as Australia and Japan (Lidbeck, 1996). The groups all measured the Earth's magnetic field and compared their results. Without the Internet, costs and logistical problems would have made such an experience impossible.

Finally, science related discussion groups on the World Wide Web enable students and teachers to interact with others around the world that share interests. Maintaining interest is key in science, so one way to encourage the one or two students in a particular class who have unique interests is to foster interactions with others who share the interest.

Finding New Sources of Information

Through the Internet, students, parents, and teachers with limited resources can access an extensive array of informational sources.

- *Virtual libraries*
  - Kids Connect @ the Library (http://www.ala.org/parentspage/)
  - The Library of Congress (http://www.loc.gov/)
  - Library Resources on the Internet (http://www. library.nwu.edu/resources/library/)
- *Reference sources*
  - Science Reference Shelf (http://www-hpcc. astro.washington.edu/scied/sciref.html)
  - Research-It! (http://www.itools.com/research-it/research-it.html)
  - Martindale's The Reference Desk (http://www-sci.lib.uci.edu/HSG/Ref.html)
  - Science FactFinder (http://www.accurate-eye.com.au/earth.htm)
- *Digitized books*
  - The On-Line Books Page: Science (http://www-cgi.cs.cmu.edu/cgi-bin/book/subjectstart?Q)
- *Search engines and directories*
  - Awesome Library (http://www.neat-schoolhouse.org/awesome.html)
  - Dogpile (http://www.dogpile.com)
  - The Virtual Library: Science (http://www.vlib.org/Science.html)

For more ideas, see *The parent's guide to the information superhighway*, online at http://www.childrenspartnership.org/pub/pbpg.html.

Seeking Assistance

There are times when each of us needs help finding specific information, learning new concepts, completing assignments, or making plans. On the Web, personal assistance is only a click away.

- *Ask the experts.* This is a sampling of question answering services available.
  - Scientific American: Ask the Experts (http://www.sciam.com/askexpert/index.html)
  - Ask Jeeves for Kids (http://www.ajkids.com/)
  - The Mad Scientist Network (http://www.madsci.org/)
- *Homework Help & Tutoring*
  - The CSMEE Homework Companion (http://www.ericse.org/homework.html)
  - The Biology Project (http://www.biology.arizona.edu/)
- *Career information* Access to career information and first hand accounts from people who have succeeded can help students know how to prepare. Here are samples of available resources.
  - ScienceWeb: Career Descriptions (http://scienceweb.dao.nrc.ca/can/careers/describe.html)
  - People in Mathematics and the Sciences (http://coolschool.edu/goto6.htm)

Staying Informed

One way to keep students interested in science is to help them notice the science of daily life. Here are websites that relate science to the news, daily events, issues, television and more.

- *News.* Science in and "behind" the news.
  - The Why Files (http://whyfiles.news.wisc.edu/)
  - ScienceNOW (http://www.sciencenow.org/)
  - Science in the Headlines (http://www.nas.edu/headlines/)
  - Earth Alert (http://www.discovery.com/news/earthalert/earthalert.html)
- *Magazines.*
  - Science News Online (http://www.sciencenews.org/)
  - *Discover* (http://www.discover.com/)
  - *Scientific American Explorations* (http://www.explorations.org/)
  - *Sky & Telescope* (http://www.skypub.com/skytel/skytel.shtml)
- *Television and Radio.* These web pages complement television and radio programming and can help to enrich the viewing experience.
  - Nova Online (http://www.pbs.org/wgbh/nova/search.html)
  - Earth & Sky (http://www.earthsky.com)
  - Bill Nye the Science Guy (http://nyelabs.kcts.org/flash_go.html)
  - Scientific American Frontiers (http://www.pbs.org/saf/)
  - A Science Odyssey (http://www.pbs.org/wgbh/aso/)
  - Zoom (http://www.pbs.org/wgbh/zoom)
- *Issues and Events of the Day.* These sites focus on current issues and events relevant to science and social perspectives.

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EPA Global Warming Site (http://earth1.epa. gov/globalwarming/home.htm)
Endangered Species (http://eelink.net/EndSpp/)
Interactive Weather (http://iwin.nws.noaa.gov/iwin/graphicsversion/main.html)
FEMA for Kids (http://www.fema.gov/kids/)
Today's Earthquake Activity (http://athena. wednet.edu/curric/land/todayqk.html)

Extending Classroom Instruction.

Self-directed learning outside the classroom is nurtured at websites offering activities, information, and media to promote interest and understanding.

- *Online Learning Centers*. These interactive sites provide access to unique resources to capture the attention of students.

  The Learning Studio @ The Exploratorium (http://www.exploratorium.edu learning_studio/)
  Thinking Fountain (http://www.sci.mus.mn.us/sln/tf/nav/tfatoz.html)
  StarChild (http://starchild.gsfc.nasa.gov/docs/StarChild/StarChild.html)
  Explorer's Club (http://www.epa.gov/kids/)
  Exploring the Environment (http://www.cotf.edu/ete/main.html)

- *Activities*. Many websites offer simple activities that can enrich school instruction, home instruction, or homework assignments.

  Whelmers (http://www.mcrel.org/whelmers/)

- *Family learning experiences*. These websites offer resources and activities that can guide the whole family in creating a learning environment.

  Too Cool For Grownups (http://www.tcfg.com/)
  Bird Conservation Initiatives (http://www.audubon.org/bird/)
  Helping Your Child Learn Science (http://www. ed.gov/pubs/parents/Science/index.html)
  The Global Schoolhouse (http://www.gsn.org/)
  The Nation's K-12 Homepage (http://www.copernicus-psd.com/)

- *Online Courses*. Online courses can be used to supplement classroom learning.

  An Astronomy Course Using the Internet (http://www.cnde.iastate.edu/staff/jtroeger/astronomy.html)

Doing Research

The websites listed here represent the opportunities available for engaging students in analyzing real-world data, examining research findings, and exploring active research efforts. For more ideas, see *Web Activities Using Scientific Data*, online at http://www.sel.noaa.gov/Activities/.

- *Data Sources*

  NOAA Server (http://www.esdim.noaa.gov/NOAAServer/)
  National Geophysical Data Center (http://www.ngdc.noaa.gov/)
  National Oceanographic Data Center (http://www.nodc.noaa.gov/)
  Water Resources of the United States (http://water.usgs.gov/)

- *Technical information*

  The Tree of Life (http://phylogeny.arizona.edu/tree/phylogeny.html)
  Internet Resource Guide for Zoology (http://www.york.biosis.org/zrdocs/zoolinfo/zoolinfo.htm)
  EPA's Surf Your Watershed (http://www.epa.gov/surf/)
  BioOnline (http://bio.com/resedu/educate.html)

- *Research centers and facilities*

  Space Scientists Online (http://quest.arc.nasa.gov/sso/index.html)
  EPA Acid Rain Program (http://www.epa.gov/docs/acidrain/ardhome.html)

Getting Involved in Projects

Though we all learn best by "doing," a major benefit of the Internet is the opportunity for individual students, families, and classroom groups to actively participate in a rich variety of projects that involve collecting and sharing data.

- *Collaborative projects*

  GLOBE Program (http://www.globe.gov/)
  Journey North (http://www.learner.org/jnorth/)
  FrogWatch USA (http://www.mp2-pwrc.usgs.gov/FrogWatch/)
  Cornell Laboratory of Ornithology (http://birds.cornell.edu/)
  Global Water Sampling Project (http://k12science.stevens-tech.edu/curriculum/waterproj/index.html)
  Houghton Mifflin Project Center (http://www.eduplace.com/projects/index.html)

- *Science fairs and competitions*

  The CSMEE Science Fair Companion (http://www.ericse.org/scifair.html)
  Odyssey of the Mind (http://www.odyssey.org/odyssey/)

- *Project ideas*

  Science Project Guidelines (http://atlas.ksc.nasa.gov/education/general/scifair.html)
  Experimental Science Projects (http://www.isd77.k12.mn.us/resources/cf/SciProjIntro.html)
  Amateur Scientist (http://earth.thesphere.com/SAS/SciAm/SciAm.html)

Enrich Personal Experience

With the strong emphasis on active learning in science, the range of experiences that a student brings to the classroom will have an effect on the learning that occurs. Here is a sampling of resources that can increase individual awareness of nature and the world beyond one's direct experiences.

- *Virtual field trips*

  Virtual Tours (http://www.dreamscape.com/frankvad/museums.html)
  The Jason Project (http://www.jasonproject.org/)
  Galapagos Quest (http://quest.classroom.com/galapagos1999/splash.asp)

- *Visits to zoos, museums, and centers*

  American Museum of Natural History (http://www.amnh.org/)
  Smithsonian Museums (http://www.si.edu/organiza/)
  Science Adventures (http://www.scienceadventures.org/)
  Zoo Links (http://www.ala-net.com/zoos.html)

- *Remote places*

  The Virtual Cave (http://www.goodearth.com/virtcave.html)
  The Nine Planets (http://www.seds.org/billa/tnp/)
  Hawaiian Volcano Observatory (http://hvo.wr.usgs.gov/)

- *Remote cameras & robots*

  Animal Cams (http://biology.miningco.com/msub2.htm)
  Bradford Robotic Telescope (http://www.telescope.org/rti/)
  Telerobot Controller (http://192.204.241.187/cgi-win/telerobt.exe)

- *Expeditions*

  Xpeditions (http://www.nationalgeographic.com/xpeditions/main.html)
  Global Online Adventure Learning Site (http://www.goals.com/)

Reference

Lidbeck, G. (1996). Confessions of a fourth grade newbie. In M. Shinohara, R. Wenn, & A. Sussman (Eds.). *Tales from the electronic frontier*. San Francisco: WestEd, pp. 42-48. (Available online at http://www.wested.org/tales/06newbie01.html.

Additional Resources

Reasons for the Internet in K-12 Schools (http://www-personal.si.umich.edu/~kenh/k12.html)
Tales from the electronic frontier (http://www.wested.org/tales/)
Science and Math Initiatives (http://www.learner.org/sami/)
Ebenezer, J. V., & Lau, E. (1999). *Science on the Internet: A resource for K-12 teachers*. Columbus, OH: Merrill.

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